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Motion of metallic microparticles in superfluid helium in the presence of space charge

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Abstract

We report an experimental and theoretical study of the motion of metallic micro- and nanoparticles in cryogenic superfluid helium in the presence of a static electric field. Depending on the polarity of the applied field, the system is charged with a large number of positive ions or free electrons. For the electrons, we observe the formation of a negative charge layer above the free surface of liquid He and a shuttle-like motion of metallic particles between this layer and the positively charged bottom electrode. For the positive ions, the positive space charge is created in the liquid and the particle motion resembles bouncing off the (negatively charged) bottom electrode. The observations are explained by a theoretical model based on classical electrostatics and hydrodynamics.

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